PATENT SPECIFICATION

624,169

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ndex at acceptance:—Class 83(iv), E(1h4:12), M(9j:19x:28).

COMPLETE SPECIFICATION

Improvements in Machines for Bending Angle and other Metal Rods, Bars or the like

We, SOCIETE NATIONALE DE CONSTRUCTIONS AERONAUTIQUES DU SUD-EST, of 6, Avenue Marceau, Paris (8°), France, a French Body Corporate, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the art of mechanically bending various sectional irons, but is more particularly concerned with the bending of sectional irons whose thickness is small relative to the extent of the sectional area.

The term "lamination" employed herein is used to designate the action of rolling, that is to say, reducing sheet metal by means of a rolling arrangement or assemblage of rolls turning side by side in opposite directions.

The machine in present use generally make use of one of the following three systems:

For a clearer comprehension of the following disclosure reference will be made for the three systems to the diagrams shown in Figures 1 to 10.

FIRST SYSTEM.

The element to be bent is supported at two points and a bending stress is exerted upon the element between the two points either by means of three rollers (Figure 1) or by means of three knives one of which is subjected to a vibratory movement (Figure 2). In this case, the distortion of the section of the bent iron is not controlled, but should be solely caused by the bending stresses. The permanent set is obtained only when the elastic limit has been exceeded in the traction area. In the case of most bending operations, the neutral line is generally located in the region of the extended fibre; the bending stress is thus substantially greater and may cause local collapse before the traction stress has reached the value of the elastic limit (inner or concave bending Figure 3). In the event of bending in the opposite direction (outer or convex bending Figure 4), condition are more favourable; but there remains a risk that the most extended fibre will be torn. Moreover the danger of collapse in the compressed area is not entirely eliminated.

It follows that the above method of bending may be only applied to irons whose height is small with respect to the thickness.

The improvements effected on certain machines to ensure more satisfactory guiding of the iron between the rollers such as for example machines with double rollers or inclined rollers, slightly improve the conditions of the bending operations, but do not entirely do away with any of the above mentioned drawbacks. To such drawbacks there may moreover be added the fact that the irons cannot be bent throughout their entire lengh; inasmuch as at each end of the iron there must be retained a straight portion corresponding to the spacing of the supporting rollers or knives.

SECOND SYSTEM.

The deformation of the initial section of the iron in order to bend the same is obtained by rolling at a uniform caliber either between two rollers rotated in opposite direction (fig. 5 and 6) or between a roller and a templet (fig. 7 and 8).

The spacing between the two rollers or between the roller and the templet is variable whereby the extent of laminating effect on the extended surface may be adjusted and the curve radius accordingly varied. In this method as in the preceding one, the deformation of the flat flange of the iron is obtained indirectly and without possibility of any control. The process may thus be applied only to irons of small width relative to their thickness.

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In the individual case of the bending of an iron between a cylindrical roller and a templet (Fig. 7 and 8), the gradual deformation of the flat flange may be to a certain extent corrected by providing with a stripping angle D (Fig. 8) the lateral surface of the roller which is in contact with the iron. However, by reason of the elastic shrinkage, the curve radius on the templet should be smaller than the radius of the bend to be obtained, which fact leads to difficulty in the determination thereof.

THIRD SYSTEM.

The deformation of the initial section of the iron is obtained by crushing the section at a gradually variable thickness, between oppositely disposed knives whose sharp edges are directed towards the centre of the curve to be obtained and which act by percussion; the knives are adjusted so that the force of that percussion is variable throughout the length of the section, the greatest percussion being exerted opposite to the point of greatest extension and the smallest or no percussion opposite to the non-extended region.

Results obtained by means of this device are satisfactory, but among drawbacks of this method may be noted the fact that the rate of output is relatively slow and that a highly experienced operator is required. Moreover bending can only be carried out in such direction that the web of the iron will be placed outside the curve, since the flange perpendicular to that web is not subjected to any extension.

The invention has for its main object to provide a remedy for the various drawbacks inherent in the three systems described above.

To this effect, it uses the third system described in which the web is subjected to a progressive crushing according to the curvature to be obtained. According to the invention, the metal beam or bar passes through a train of positively controlled rollers, of some of which are employed to roll the web or flanges of the beam according to the curvature of the work and at least one of which has its generatrices non-parallel to the surface of the beam on which it bears to crush the web or flange corresponding to this surface by a gradual decreasing amount in direction of the centre of the curvature and the invention is characterised in that the machine comprises means to control the angle of rolling of the rollers, which means can be controlled during rolling operations to vary the radius of curvature of the profile in the direction of the bend.

In bending machines embodying the improvement according to the invention as hereabove essentially defined, the number of rollers, their outline and their relative arrangement are variable according to the shape and the cross-section of the iron to be bent. But, in all cases, the invention is applicable regardless of the relative thickness or caliber of the iron with respect to the sectional areas, inasmuch as the deformation (extension or compression of any fibre is always directly controlled by at least one roller and consequently folds and distortion are avoided in the flanges.

Bending machines according to the invention may in particular comprise the following main features:

a) all rollers of trains used for the bending of sectional irons are controlled either individually or by operative connection with one of said rollers directly controlled;

b) The variably spaced cylindrical rollers which propel the iron to be bent by acting on one of the flanges thereof may moreover produce laminating effect on said flange in the event where the same is extended after bending;

c) The main laminating rollers are frusto-conical and journaled in a pivotal support allowing for displacement of the pivotal fulcrum of the rollers according to whether the bend to be obtained is convex or concave.

d) The main laminating rollers are cylindrical, in which case the access of one of the variably spaced rollers is inclinable with respect to the other axis which is fixed.

The accompanying drawings given by way of example only show various forms of embodiments of a bending machine for sectional irons and of devices pertaining to such bending operations as improved according to the invention.

Figs. 1 to 10 are operational diagrams relating to previous devices as used in the art.

Fig. 11 is a general perspective view of a bending machine provided with two cylinderical rollers having parallel axes and a frusto-conical roller mounted in a pivotal support.

Fig. 12 is a diagrammatic perspective view corresponding to Fig. 11 and showing the driving mechanism of the various rollers.

Figs. 13 to 18 are operational diagrams illustrating the bending of irons having various cross-sections by means of the machine shown in Figs. 11 and 12.

Figs. 13 and 14 relate to the bending of a Z sectional iron.

Figs. 15 and 16 relate to the bending of an angle-iron whereof the plane flange is extended.

Figs. 17 and 18 relate to the axial bend-

ing of a channel iron.

Figs. 19 and 20 diagrammatically show the bending of an omega sectioned iron on a machine provided with a train of two frusto-conical rollers.

Figs. 21 and 22 show an alternative embodiment for the bending of an angle iron having its flat flange outwardly disposed by means of two cylindrical rollers one of which is inclinable.

Figs. 23 and 24 show an alternative embodiment for axially bending a channel iron by means of two cylindrical rollers of different breadths and one of which is inclinable.

As shown in Fig. 12, the main shaft 1 rotating the cylindrical rollers 2 and 3 and the frusto-conical roller 4 is provided at its lower end with a worm wheel 5 driven by a worm 6 keyed on the shaft 7 of a grooved pulley 8 driven by the motor 9.

A pinion 10 cut out in or keyed on the main shaft 1 ensures rotation of the cylindrical roller of greater diameter 2 through a two-staged pinion 11 journalled, as are also all the other pinions, in bearings of the main housing 12 or in pivotal supports such as 13 of the frame of the machine (Figure 11). A cylindrical straight-toothed gear 15 keyed on the shaft 16 of the roller 2 ensures both the rotation of said roller 2 and the movement in reverse direction of the roller of lesser diameter 3 through a train of cylindrical pinions 17 and 17a journalled similarly to the shaft 18 carrying roller 3 in a pivotal support, not shown in the drawings, in order to allow for adjustment of the spacing of cylindrical rollers 2 and 3 whose axes are parallel, according to the calibre of the iron being bent. The frusto-conical roller 4 is fixed to a shaft 19 contained in the same vertical plane as that containing the centre line of the cylindrical rollers 2 and 3. The shaft 19 is journalled in the pivotal support 13 and driven in rotation through a train of cylindrical gears 20 and 21 operationally connected with bevel gears 22, 23 and 24 driven by a bevel gear 26 fixed to the shaft 25 and a bevel gear 27 keyed on the main shaft 1 which is parallel to the shafts 16 and 18.

The roller 4 is subjected to two controlled movements one of which fixes the axis of rotation X—X of the pivotal support 13, the other determines the angular position of the roller 4 in relation to this axis.

The pivotal support 13 contains the cylindrical gear 20 and 21 and the bevel gears 22, 23 and 24. It carries two welded side-plates such as 35, one serving as support for the bearing for a shaft 37 carrying the bevel gear 23, the other having an exterior cylindrical projection 38 coaxial with the shaft 37 (Figures 11 and 12). The pivotal support 13 pivots around this axis and said projection 38 both of which are supported by a sliding chassis 39 attached to the main frame.

At its bottom end, the pivotal support 13 has two transverse screws 41 slidably mounted through two horizontal slits 42 worked in two vertical side plates 43 operated by a wheel 28c, for allowing said support to be locked on said vertical side plates. At their bottom end, the side plates have two vertical slits 44 engaging pins integral with a nut 45 operated by a screw pin 46 controlled by the wheel 28c.

This arrangement operates as follows:— the screws 41 are loosened, the pivotal support and the frame 39 start sliding in such a manner as to lock the axis X—X in the required position, the nut 45 is displaced along the screw pin 46 and the screws 41 being consequently tightened. By turning the wheel 28c, the pivotal movement of the side plates 43, and consequently of the pivotal support 13, about the axis X—X is obtained.

The diameter of the cylindrical rollers 2 and 3 that of the frusto-conical roller 4 as well as the ratio between the number of teeth of the various trains of pinions of the power transmission are calculated so as to ensure the feeding motion of the iron through the machine without any skidding between the lateral faces of the rollers and the sides of the iron. In Figure 12, the sectional iron P to be bent is represented in dots and dashes as an angle iron wherein the flat flange is compressed. To this end, the generatrix of the frusto-conical roller 4 is inclined with respect to the horizontal plane containing the upper plane surface to the greater roller 2, from the top towards the bottom, to provide the crushing of the vertical flange of said sectional iron P by a gradual decreasing amount in the direction of the centre of the curvature positioned with respect to said vertical flange on the same side as the centre of said roller 2; simultaneously the curved flange is compressed or crushed uniformly throughout its breadth between the cylindrical rollers 2 and 3 whose adjustment is effected by any suitable means as for example by hand-wheels 28 as shown in Fig. 11. The rollers 2, 3 and 4 are removable with a view to utilise a set of rollers corresponding to the dimensions and to the shape of the special irons to be bent. The number of said rollers may be greater than that of the rollers illustrated in Fig 12, as shown in Fig. 19.

With the arrangement of the rollers 2, 3 and 4 shown in Fig. 12 it would be similarly possible to bend the angle irons

in the opposite direction, that is the flat flange being extended (Figs. 15 and 16): in that case, the rollers 2 and 3 play a part in the feeding of the iron through the machine but do not exert a gripping effect on the compressed flange. The pivotal fulcrum of the support of the frusto-conical roller is then contained in the same vertical plane as the compressed flange, whereas in the first example described the pivotal fulcrum point $a1$ was located towards the interior of the iron.

The diagrams illustrated in Figs. 13 and 14 which correspond to the arrangement shown in Figs. 12 and 15 illustrate the bending of a Z iron. The rollers 2 and 3 laminate the extended flange, the frusto-conical roller 4 gradually crushes the web P1 of the iron towards the extended flange, and the practical pivotal point of the support of the roller 4 is located inwardly with respect to the iron P. Theoretically, the pivotal fulcrum should be at A, and is deviated to A2 for constructional reasons, only, the drawbacks result from such deviation being negligible.

In Fig. 17 the roller 2 has been replaced by a roller provided with a cylindrical journal 2a to allow for axial centring of a channel iron P_3. In this case, the extended flange is uniformly laminated between the journal 2a and the roller 3, the web P_{3a} gradually crushed towards the extended flange and the pivotal center of the support of roller 4 is placed inwardly with respect to the iron. The same result could also be obtained by slightly inclining the roller 3 to the position 3a as shown in Fig. 23. In this case, the frusto-conical roller is superfluous but it is necessary to adapt the compressed flange of the corresponding face of roller 2 and to provide a clearance between the opposite face of said roller and the extended flange to allow for the feed of the iron as the bending progresses. The same thing is true of the bending of an angle iron wherein the plane flange is extended (Figs. 21 and 22); it is sufficient to incline the roller 3 to the position 3b and to thereby suppress the frusto-conical roller. In both examples, the rollers 2, 3a and 3b are also driven either by a single motor or by separate motors.

For the bending of an iron P_4 having an omega section (Fig. 19 and 20) two frusto-conical rollers should be provided symmetrically disposed with respect to the greater roller which is provided with cylindrical rollers 26 for guiding the compressed flanges.

The cross-web P_{4a} is uniformly laminated between the cylindrical roller 3 and the large diameter surface of the roller 2, and the parallel webs of the iron are gradually laminated towards the centre web P_{4a} between the lateral faces of the above mentioned roller and the rollers 4 and 4a.

In order to operate on channel, angle, omega, Z or other irons, the machine may be provided with an appropriate setting device enabling the rollers 2 and 3 to be changed according to the selected section; to obtain a convex or concave bend, i.e. a curve in which the plane flange, the web or the cross-web is extended or compressed, it is simply necessary to alter the angular setting of the frusto-conical roller and to cause the curved flange to be laminated or not between the cylindrical rollers as the case may be.

The invention is of course not to be limited by the examples of embodiment hereabove described and illustrated, but by the essential characteristics set forth at the beginning of the above description, and comprises within its scope all means and combinations of means which may be suitable to embody said characteristics.

The bending machine for sectional irons improved according to the various characteristics hereinabove described constitute a novel industrial product claimed as such by the invention.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Improvements in machines for bending metal beams or rods of any section, said machines being of the kind in which the beams or rods pass through a train of positively controlled rollers, some of which are employed to roll the web or the flanges of the beam according to the curvature of the work and at least one of which has its generatrices non-parallel to the surface of the beam on which it bears in order to crush the web or flange corresponding to this surface by a gradual decreasing amount in the direction of the centre of the curvature, characterised in that these machines have means to control the angle of rolling of the rollers, which means can be controlled during rolling operations to vary the radius of curvature of the profile in the direction of the bend.

2. Improvements in machines for bending section irons according to Claim 1, characterised in that the rollers for laminating the web of the section iron comprise a pair of cylindrical rollers disposed opposite one another and having non-parallel axes of rotation.

3. Improvements in machines for bending section irons according to

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Claim 1, characterised in that the rollers for laminating the web of the section iron comprise a pair of rollers disposed opposite one another, one of which is cylindrical while the other is of frusto-conical shape.

4. Improvements in machines for bending angle irons according to Claim 1, characterised in that the rollers for laminating one of the flanges of the section iron comprise two cylindrical rollers disposed opposite one another, between which is disposed the flange of the angle iron which is to be bent transversely with respect to its plane, and a third roller of frusto-conical form for laminating the other web of the angle iron and bearing against the circular extremity of one of the said cylindrical rollers.

5. Improvements in machines for bending section irons of **Z**-form, according to claim 1, characterised in that the train of rollers comprises two cylindrical rollers disposed opposite one another, having their axes of rotation parallel and enclosing one of the flanges of the section irons, and a third roller of frusto-conical form adapted to laminate the web of the section iron by bearing against the circular lateral face of one the said cylindrical rollers.

6. Improvements in machines for bending section irons of **U**-form, according to claim 1, characterised in that the train of rollers comprises a first cylindrical roller engaged between the flanges of the section iron, the diameter of these rollers corresponding to the distance between the flanges and the web of the said section iron, which bears against the circular lateral face of the said first roller, two cylindrical rollers, one disposed on each side of the flanges of the section iron, and a roller of frusto-conical shape adapted to laminate the web of the section iron by bearing against the circular lateral face of the first roller.

7. Improvements in machines for bending section irons of Ω form, according to claim 1, characterised in that the train of rollers comprises a pair of cylindrical rollers disposed opposite one another and having their axes of rotation parallel to one another, one of which cylindrical rollers is engaged inside the section iron, and a pair of frusto-conical rollers disposed on either side of the lateral flanges of the section iron and adapted to laminate the said flanges by bearing against the circular lateral faces of the roller which is engaged inside the section iron.

8. Improvements in machines for bending section irons of **U**-form, according to claim 1, characterised in that the train of rollers comprises a pair of cylindrical rollers disposed opposite one another, the axes of rotation of which are non-parallel, and one of which is engaged between the flanges of the section iron, while the other is in contact with the inner face of the said section iron.

9. A machine for bending section irons substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 19th day of October, 1945.

SOCIETE NATIONALE DES CONSTRUCTIONS AERONAUTIQUES DU SUD-EST.

Per: Boult, Wade, & Tennant.

111/112, Hatton Garden, London, E.C.1.,

Chartered Patent Agents.

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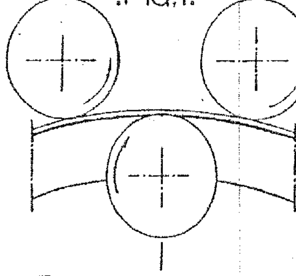
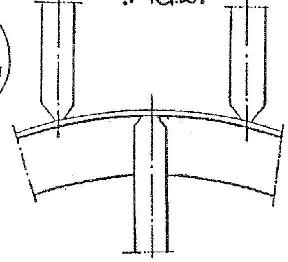
SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

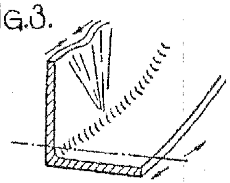
.Fig.1.



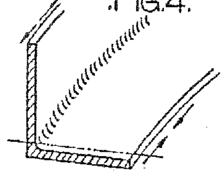
.Fig.2.



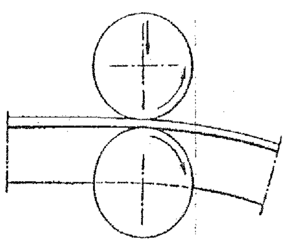
.Fig.3.



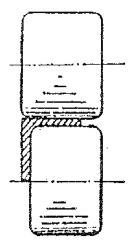
.Fig.4.



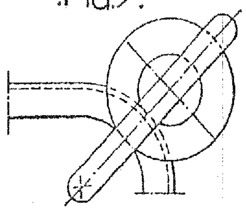
.Fig.5.



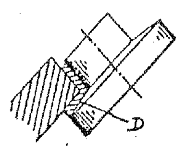
.Fig.6.



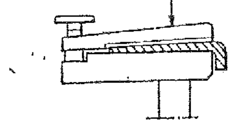
.Fig.7.



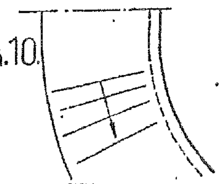
.Fig.8.



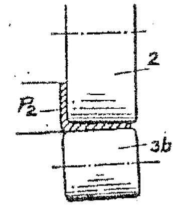
.Fig.9.



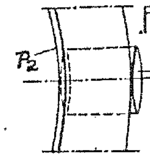
.Fig.10.



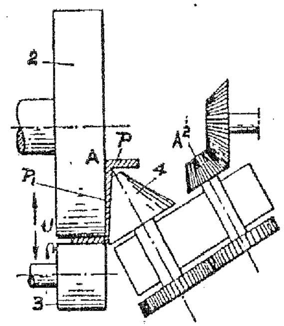
.Fig.21.



.Fig.22



.Fig.13.



.Fig.14.

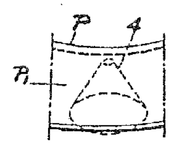
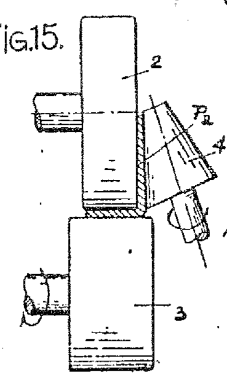
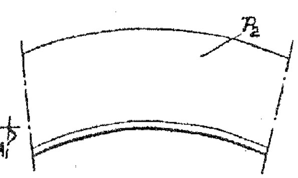


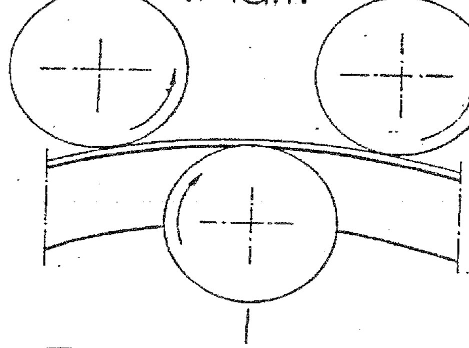
Fig.15.



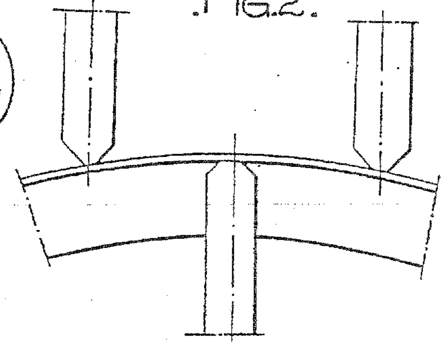
.Fig.16.



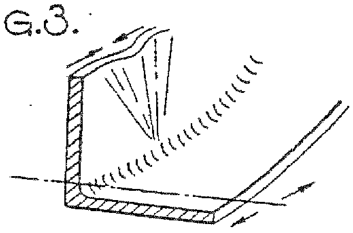
.Fig.1.



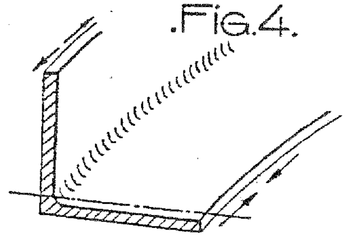
.Fig.2.



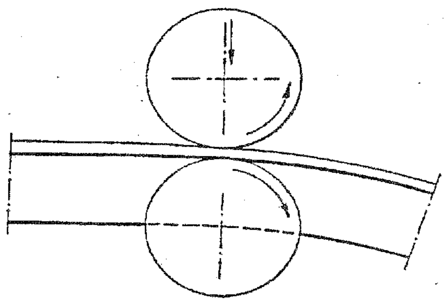
.Fig.3.



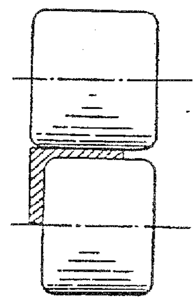
.Fig.4.



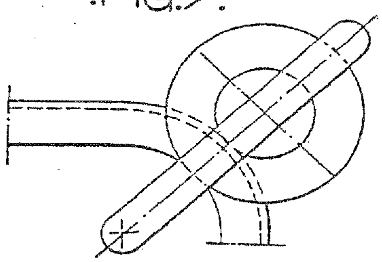
.Fig.5.



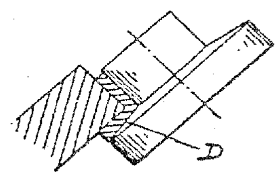
.Fig.6.

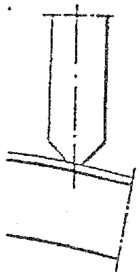


.Fig.7.



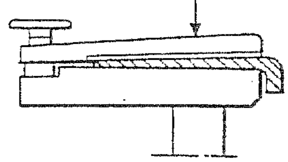
.Fig 8.



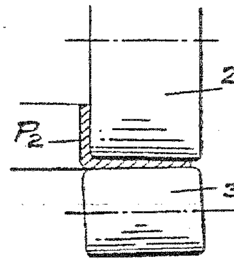


4.

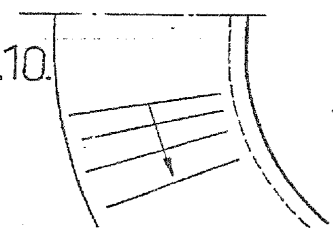
.FIG.9.



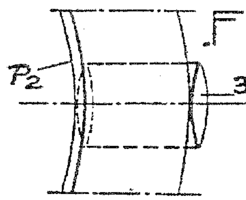
.FIG.21.



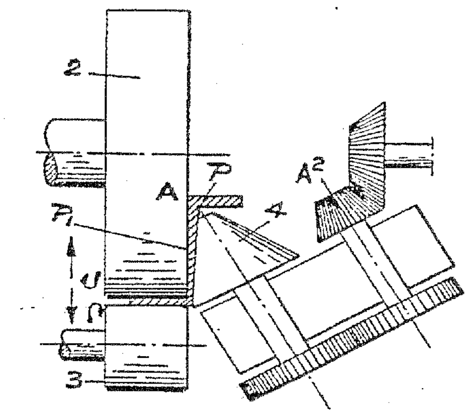
.FIG.10.



.FIG.22



.FIG.13.



.FIG.14.

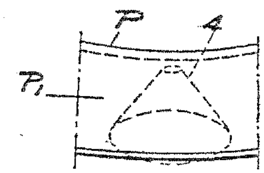
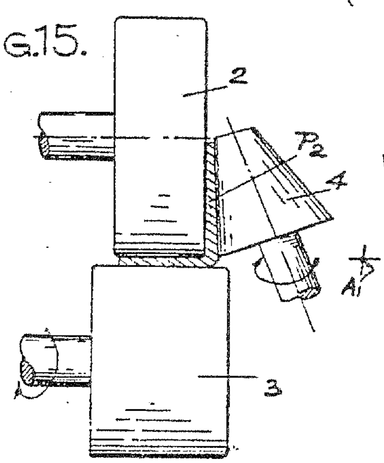
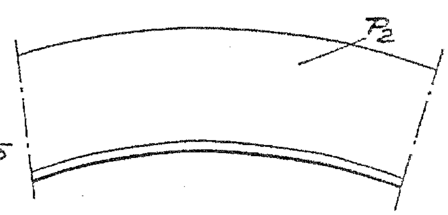


FIG.15.



.FIG.16.



[This Drawing is a reproduction of the Original on a reduced scale.]

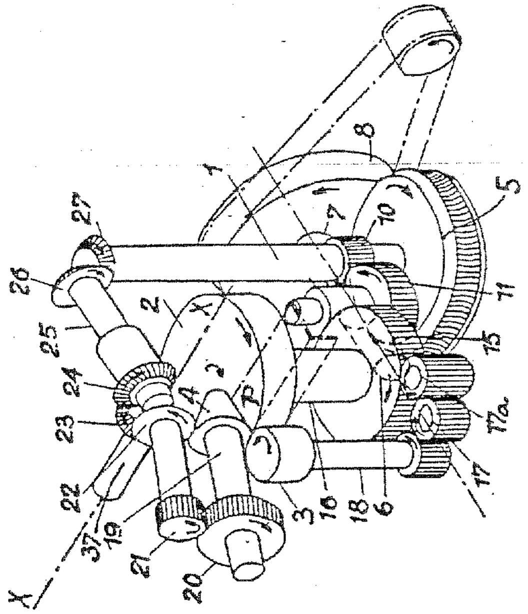


Fig.12.

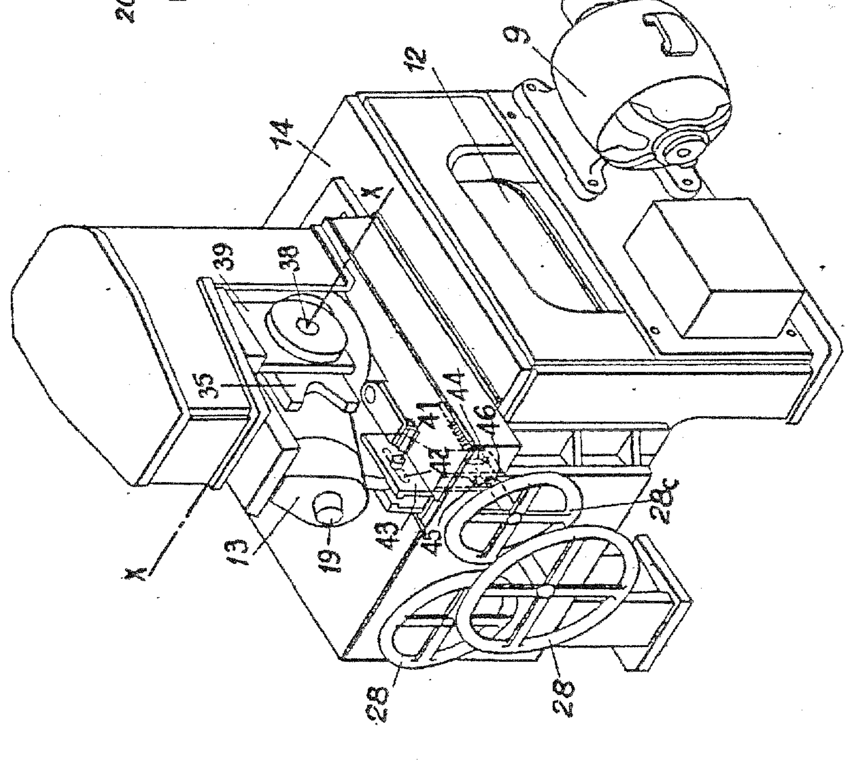


Fig.11.

Fig.17.

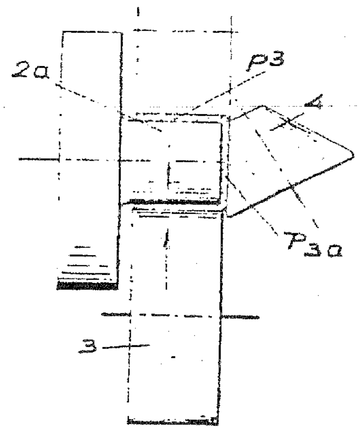


Fig.18.

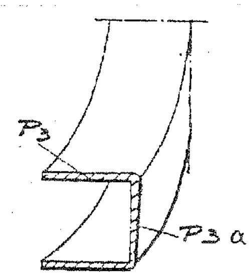


Fig.19.

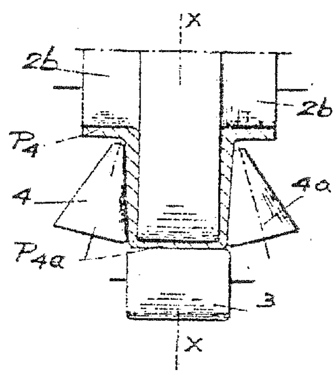


Fig.20.

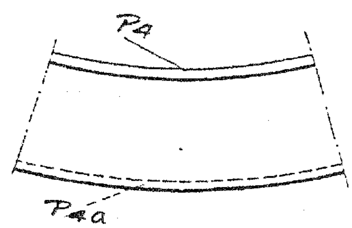


Fig.23.

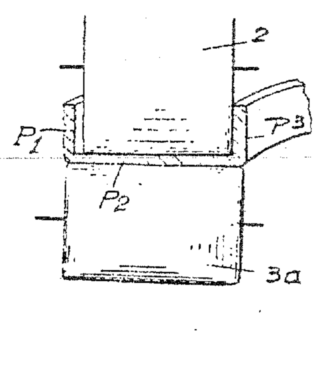


Fig.24